in the present specification, X-ray reflectometry type systems were not used to determine properties of patterned wafers. In the past, since the feature sizes on a patterned wafer were on the order of one micron, and since even test sites on a patterned wafer have dimensions typically smaller than 100 microns, the accurate determination of single or two-layer metal thicknesses on a patterned wafer was believed to be very difficult. The approach described in the specification provides the capability for measuring the thin films on patterned wafers while still using a one-millimeter spot size which is larger than the feature size on the patterned wafer. See, specification, pp. 4-5.

As discussed in the specification a "patterned wafer" refers to a semiconductor wafer whose surface bears an artificial pattern whose features are small in size relative to the spot size of the X-ray probe beam. See, specification, p. 9.

Each of the rejected independent claims recites a patterned wafer in connection with an X-ray probe beam, and using the X-ray probe beam reflected off the patterned wafer to determine characteristics of thin film layers. For ease of reference the pending independent claims are shown below:

> 1. A method for evaluating characteristics of thin film layers of a patterned semiconductor wafer comprising the steps of:
> generating a probe beam of X-rays;
> directing said probe beam onto the surface of said patterned wafer such that the spot size of said probe beam is large relative to the feature size of the pattern on said surface of said patterned wafer;
> measuring the intensity of various X-rays as reflected from said patterned wafer to generate reflectivity data; and
> analyzing said reflectivity data to determine characteristics of said thin film layers.
>
> 11. A method for evaluating characteristics of thin film layers of a patterned semiconductor wafer comprising the steps of:
> generating a probe beam of X-rays;
> focusing said probe beam on the surface of said patterned wafer such that various X-rays within the focused probe beam create a range of angles of incidence with respect to said surface and such that the spot size of said probe beam is large relative to the feature size of the pattern on said surface of said patterned wafer;
> measuring the intensity of various X-rays as a function of position within the probe beam as reflected with the positions of the X-rays within said reflected probe beam corresponding to specific angles of incidence with respect to said surface, thereby generating reflectivity data; and
> analyzing said reflectivity data to determine characteristics of said thin film layers.
>
> 20. A method for evaluating characteristics of thin film layers of a patterned semiconductor wafer comprising the steps of:
> generating a probe beam of X-rays having a broad spectrum of energies;
> directing said probe beam onto the surface of said patterned wafer such that the spot size of said probe beam is large relative to the feature size of the pattern on said surface of said patterned wafer;
> measuring the intensity of various X-rays as reflected from said patterned wafer to generate reflectivity data measuring reflected X-ray intensity as a function of X-ray energy; and

analyzing said reflectivity data to determine characteristics of said thin film layers.

29. An apparatus for evaluating characteristics of thin film layers of a patterned semiconductor wafer comprising:

a source for generating a probe beam of X-rays;

means for directing said probe beam onto the surface of said patterned wafer such that the spot size of said probe beam is large relative to the feature size of the pattern on said surface of said patterned wafer;

a detector for measuring the intensity of various X-rays as reflected from said patterned wafer to generate reflectivity data; and

processor means for analyzing said reflectivity data to determine characteristics of said thin film layers.

It is respectfully submitted that in contrast with the above claims Komiya does not disclose or suggest a method or system where an X-ray probe beam is reflected off a patterned wafer to determine properties of thin film layers. In connection with the rejection of independent claims 1, 11, 20 and 29, the Office Action states in part that Komiya teaches a method and apparatus which includes:

> "Directing the probe beam onto the surface of the patterned wafer such that the spot size of the probe beam is large relative to the feature size of the pattern of the surface of the patterned wafer (column 5 line 34+);
>
> "Measuring the intensity of various rays as reflected from the patterned wafer to generate reflectivity data (column 5 line 37+) . . . ."

Office Action, p. 3.

It is respectfully submitted that Komiya does not appear to suggest focusing a probe beam on a patterned wafer as recited by claims 1, 11, 20 and 29. Indeed, it is respectfully submitted that the discussion from column 5 of Komiya shows that the wafer surface where the X-rays are directed is not patterned. For example, Fig. 1A, Fig. 1C and Fig. 1E (which are discussed in column 5 of Komiya) each show X-rays being reflected off a wafer. Significantly in each case the wafer is shown as not being a patterned wafer as recited by the claims 1, 11, 20, and 29. Comparing Figs. 1A, 1C and 1E of Komiya to Fig. 5 of the present application illustrates a difference between the directing a probe of X-rays to a patterned wafer (as shown in Fig. 5) versus an unpatterned wafers as shown in Fig. 1A, 1C and 1E.

Further, given the discussion of Komiya, and the fact that each example of a wafer shown in Komiya is not patterned, it appears that there is nothing to suggest that the system of Komiya could be using to measure thin films of patterned wafers.

In light of the above, it is respectfully submitted that claims 1, 11, 20 and 29 are neither anticipated by, or obvious in light of Komiya. Each of the remaining pending claims are

dependent claims, which depend from the above discussed independent claims, and thus it is respectfully submitted that these dependent claims are patentable for at least the same reasons as the independent claims.

It is noted that in connection with rejecting claims 3-7, 13-17 and 22-26 under 35 USC §103, the Office Action relies on Komiya in view of Koppel (US 5,619,548). The Koppel reference is cited in the Office Action for teaching regarding elements other than directing X-rays to a patterned wafer. Indeed, it is respectfully submitted that the Koppel reference does not appear to disclose directing X-ray probe beams to a patterned wafer. Thus, it is respectfully submitted that the Koppel and Komiya references do not disclose or suggest the pending claims.

Drawings

The Office Action objected to the drawings because Figs. 1-2 and 5 were not designated as prior art. See, Office Action, p. 2. Submitted herewith a copy of the drawings with changes indicated in red to add the caption "Prior Art" to Figs. 1 and 2. In connection with Fig. 5 the caption "Prior Art" has not been added because the Fig. 5 does not show the prior art, in that it shows a cross-sectional view of a line pattern of barriers on a patterned wafer sample and the incidence of X-rays onto the surface of the sample.

The Office Action also objected to the Fig. 1 because box 60 was empty. See, Office Action, p. 2. As shown in the changes indicated in red, the word "processor" has now been added to the box 60.

The Office Action also required new formal drawings. See, Office Action, p. 2. Provided herewith a copy of the formal drawings that are being concurrently being submitted to the official draftsperson. These formal drawings incorporate the changes which are indicated in red on the corrected pages of the informal drawings.

CONCLUSION

For the reasons set forth above, it is believed that all claims now present in this application are patentably distinguishable over the prior art. Therefore, reconsideration is requested, and it is requested that this application be passed to allowance.

Respectfully submitted,

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